Chroma®

PROGRAMMABLE AC SOURCE 6400 Series

Service Manual

PROGRAMMABLE AC SOURCE

Service Manual

Models : 6404 、 6408-1 、 6408-2

CHROMA ATE INC.

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Warranty

All Chroma instruments are warranted against defects in material and workmanship for a period of one year after date of shipment. Chroma agrees to repair or replace any assembly or component found to be defective, under normal use during this period. Chroma's obligation under this warranty is limited solely to repairing any such instrument which in Chroma's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center. Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Chroma.

This warranty does not apply to any products repaired or altered by persons not authorized by Chroma, or not in accordance with instructions furnished by Chroma. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Chroma assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment. High voltage used in some instruments may be dangerous if misused. Special disclaimers apply to these instruments. Chroma assumes no liability for secondary charges or consequential damages and in any event, Chroma's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Chroma for use of its products are based upon tests believed to be reliable, but Chroma makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Chroma any liability in connection with the sale of our products other than set forth herein.

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SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation , service , and repair of this instrument. Failure to comply with these precautions or with specific WARNINGS given elsewhere in this manual violates safety standards of design , manufacture , and intended use of the instrument. *Chroma* Electric Corporation assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER
Verify that the product is set to match the line voltage.

PROTECTIVE GROUNDING
Make sure to connect the protective grounding to prevent an electric shock before turning on the power.

NECESSITY OF PROTECTIVE GROUNDING
Never cut off the internal or external protective grounding wire or disconnect the wiring of protective grounding terminal. Doing so will cause a potential shock hazard that could result in personal injury.

FUSES
Fuses are contained inside the unit , and are not user-replaceable. Only trained service personnel should replace the required rated current , voltage and specified type (normal blow , time delay , etc) fuses , and only after identifying and correcting the problem which caused the fuse (s) to blow. Do not use different fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE
Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS
Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel. Do not replace components with the power cable connected. Under certain conditions , dangerous voltages may exist even with the power cable removed. To avoid injuries , always disconnect power , discharge circuits and remove external voltage sources before touching components.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT
Because of the danger of introducing additional hazards , do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Chroma Sales and Service Office for service and repair to ensure that safety features are maintained.

WARNING	*LETHAL VOLTAGES.* **Ac sources can supply 426 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.**

SAFETY SYMBOLS

	**DANGER** - High voltage .
	**Explanation** : To avoid injury , death of personnel or damage to the instrument , you must refer to an explanation in the instruction manual .
	**Protective grounding terminal** : To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
WARNING	A **WARNING** sign denotes a hazard. It calls attention to a procedure , practice , condition or the like , which , if not correctly performed or adhered to , could result in injury or death of personnel.

Table of Contents

Chapter 5
Trouble shooting

Appendix

Chapter1
General Information

1.1. Introduction

This manual has information to perform calibration , adjustment , basic maintenance and trouble shooting of the 6404/6408 programmable AC Power Source. This manual is intended for use by service trained personnel only.

Detailed information for operating and programming is excluded from this manual. Only sufficient information for service purposes is included. For more detailed operating and porgramming information , refer to the 6404/6408 user's manual.

WARNING

The information in this manual is for the use of service trained personnel only.

To avoid electrical shock , do not perform any procedures in this manual or do any servicing to the 6404/6408 Ac power source , unless you are qualified to do so.

1.2. Test Equipment Required :

TYPE	Required Characteristics	USE
DMM	5 1/2 digits	T 、C
Current Shunt	Accuracy with 0.01A	C
Load	800W	C
T : Trouble shooting	C : Calibration	

Chapter2
Basic Operation Information

2.1. Input power requirements

Model	input voltage range	input frequency range	input current
6404	90-132V	47Hz-63Hz	7A Max
	180-250V	47Hz-63Hz	3.5A Max
6408-1	90-132V	47Hz-63Hz	12A Max
6408-2	180-250V	47Hz-63Hz	6A Max

**** CAUTION ****

The instrument may be damaged if it is operated at an input voltage that is outside the configured input range.

2.2. Input Connection

The input outlet is located on the rear panel of the insturment. Refer to Figure 2-1 on the following page. The instrument must be operated from a three-wire single phase AC power source. The power source must have a current rating greater than or equal to the instrument fuse rating.

WARNING

To protect operating personnel, the wire connected to the or GND terminal must be connected to an earth ground. In no event should this instrument be operated without an adequate ground connection.

2.3. Power-on Procedure

Apply the line power and turn on the front panel power switch. No loads should be connected to the output terminal block. The instrument performs a series of self tests each time when turning on the power-switch. All front panel LEDS , including alphanumeric and indicator LEDs , are turned on and holds about 3 seconds. Then , the seven segment LEDs , alphanumeric LEDs will show "SELF TEST" indicating that the 6408/6404 is running self-test routines.

Then , the seven segment LEDs display model number (6408 or 6404) , firmware version number (e.g. " ver 1.2 ") as below :

6408 ver 1.2

If any error is detected during the self-test routine , an error message will be displayed on the LED. For example.

RAM TEST ERR

The following table shows all the error messages and recommended actions :

Item	Error Message	Description	Action
1	RAM TEST ERR	System memory test failure.	refer to Trouble Shooting in Chapter 5
2	EEPROM ERR	System EEPROM test failure.	
3	DSP COMM ERR	CPU and DSP communication test failure.	

After the self-test routines are completed the LEDs turn to show the current setting values of V and F , and measured value of I , indicating the 6408/6404 is ready for use as below :

0.0 60.0 0.00

** WARNING **

Before the instrument is turned on , all protective earth terminals , extension cords , and devices connected to the instrument should be connected to a protective earth ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.

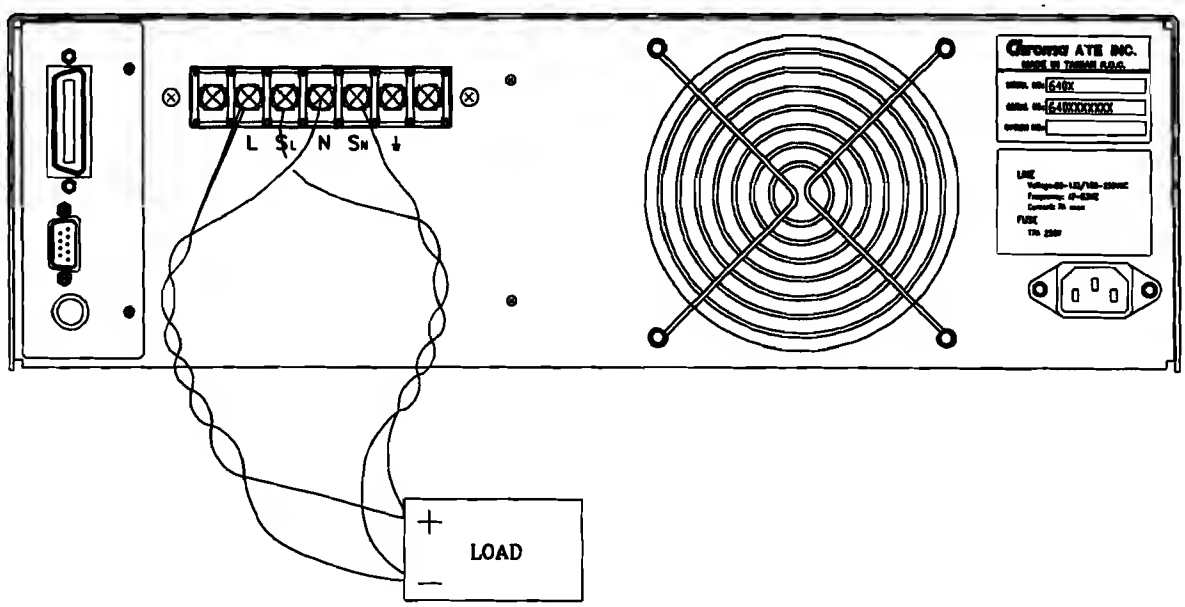


Figure 2-1 Rear Panel

Chapter3
Theory Of Operation

3.1. General

The 6408/6404 AC power source consists of 8 main boards and other discrete components. Each has its specific function that will be described in the sections followed.

3.2. Overall System Description

Figure 3-1. shows the overall system blocks. Main power flows through the A/D , D/A power stage converter. The A/D power stage is designated as **I board** and generates DC voltage from the line input. The DC voltage of the A/D output is applied to the input of the next power stage.

The **P board** of D/A stage take power from the A/D output , the fan speed control circuit is also on **P board**.

The isolated output transformer takes power from D/A output and transfer it to two sets at secondary , connected in parallel or serial at **O board** to obtain more current or higher voltage.

A board is identified as **CPU**. The 64180 CPU is used here to communicate with DSP at **B board** for programming variable output voltages and frequencies , to monitor or control the signal and interrupts , and to perform remote control through the GPIB or RS-232C interface on the optional board.

B board is identified as the sine wave generator , measurement unit , and D/A power stage controllers. It generates sine waves acting as the reference input of the D/A stage. All measurement functions are done here.

The seven-segment LEDs and keyboard are identified as **D board** and **K board** respectively , which makes the interfaces between the user and the instrument. Fan is used to remove extra heat from interior of the 6408/6404 AC Source.

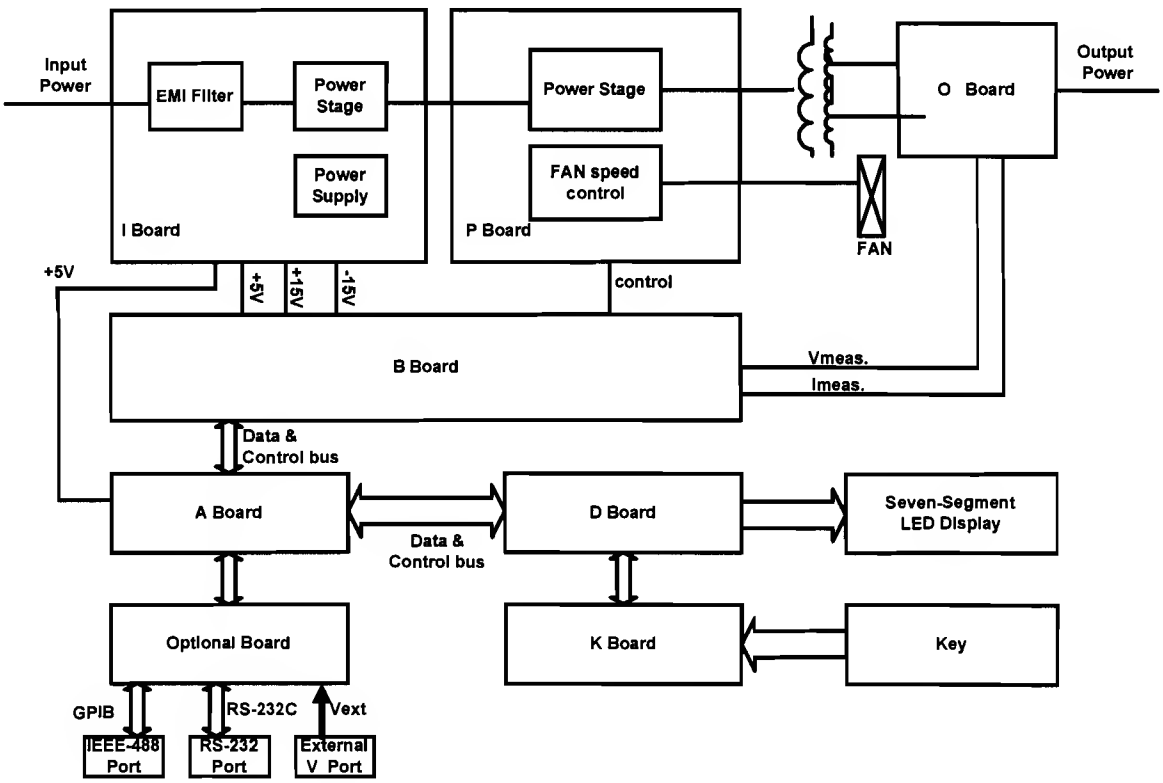


Figure 3-1 System Block Diagram

3.3. AC/DC Power Stage Converter

This assembly is identified as I board. It generates the high voltage Vdc supply. This power stage also include power supply circuits that generate the DC voltage identified as +15V , -15V , +5V. Power factor correction technology for 6408 is used to achieve a power factor of 0.98 or more.

3.4. DC/AC Inverter

This assembly comprises of control part at **B board , P board** , output transformer , **O board**. It generates an AC output sine wave.

Advanced PWM technology is applied to this system to obtain more stability. Maximum peak current is clamped to protect output power MOSFET. Overload protection (OLP) , which contains output protection against short circuit , is also implemented here.

P board is made up of the full bridge of MOSFET power components. The PWM control signal from controller is applied to the full bridge to amplify the output. The low pass filter can reject the switching frequency component.

O board consists of the range relays and output relays. Output relays can isolate the AC source from the external source when any error occurs. Range relays connect the two sets of the secondary of output transformer together in parallel or serial.

3.5. CPU

The CPU , A board , uses a 64180 CPU to control the circuit. A microprocessor circuit accepts commands from the GPIB or RS-232C controller , or from the front panel keyboard. It sends digital programming information to DSP controller to set the output parameters of the power source. Data from measurement circuits are accepted and reported to the display and GPIB. Setup parameters and one key operation data are stored in EEPROM.

3.6. Measurement and Sine wave Generator (B board)

Measurement circuits on **B board** monitor voltage , current , power etc. Voltage from the output is scaled , and sent to the DSP processor by the analog-to-digital converter.

Current sensed by the current shunt is scaled , and sent to the DSP processor by the analog-to-digital converter.

The true-RMS measurement is made by software of the DSP processor , and so is the power.

The digital-to-analog converter on **B board** sets the DC voltages that are used for the programmable voltage function. Low pass filter is applied to smooth the reference input signal.

3.7. Keyboard and Display

The keyboard is designated as **K board** which is connected through a short flat ribbon cable. It holds 16 key switches and 2 LED indicators. The display is also connected from **B board** through a short flat ribbon cable. It comprises of three 4-digit seven-segment LEDs. Programming of V , F can also be done by rotary knob on the front panel.

3.8. GPIB/RS-232C/External reference

The remote control is done through the GPIB or RS-232C interface on the optional board which is connected through the flat ribbon cable from **A board**. External reference is for the user to use DC reference to control the amplitude of output AC voltage.

Chapter4
Adjustment

4.1. Introduction

This section provides basic adjustment information for the 6408/6404 AC power source. The operation verification tests comprise a short procedure to verify that the unit is performing properly , without testing all specified parameters. After trouble shooting and repair of a defective unit you can usually verify proper operation with the adjustment procedure in order to ensure a proper performance.

4.2. Initial Setup

a. Disconnect the line cable and all loads from rear terminals.
b. Remove the top cover by removing the top screws.
c. Reconnect line cable and turn on AC power.
d. Turn off AC power when making or removing connections to the power source.

4.3. Reference voltage check & adjustment

Set DMM at DC range to measure the test pin of TPREF of B-board.(DMM Low at AG , High at the test pin)

Trim the VR6 to adjust the voltage of TPREF into the range : -5.1200±0.0004V.

4.4. Measurement adjustment

This section contains the adjustment procedure to verify the measurement of the output voltage and current of the AC Source.

If the measurement result is inaccurate enough , the user may recalibrate it according to following procedure.

Note : Before doing the adjustment , make sure the ext-prog LED is off.

4.4.1. Voltage Measurement adjustment :

press 〈 **SHIFT** 〉 key and make sure the shift LED " ON " , then keep pressing the 〈 **3** 〉 and 〈 **4** 〉 keys simutaneously about three seconds until the display shows :

press 〈 **4** 〉 , 〈 **ENTER** 〉 , and the display will show :

Note : you can exit from this adjustment by pressing 〈 **OUT/QUIT** 〉 key.

Use the DMM to measure the AC source output voltage.
press 〈 **1** 〉 and the display shows :

Trim the RX20 of B-Board until DMM Reading = 150.0±0.1V , then press 〈 **2** 〉 and the Display shows :

XXXX is the measured value of the output voltage V_0

adjust VR2 until XXXX = $V_0 \pm$ 0.0V , then press 〈 **ENTER** 〉

adjust VR1 until XXXX = $V_0 \pm$ 0.0V , then press 〈 **ENTER** 〉

adjust VR3 until DMM reading = 150.0 ± 0.1V

Then the adjustment of output voltage accuracy and voltage measurement accuracy is completed through above procedures.

You can press 〈 **OUT/QUIT** 〉 key twice to exit from voltage measurement adjustmer

4.4.2. Current Measurement Adjustment

make sure the voltage range is in the 150V range.

1> Set Vout = 110V , F = 60Hz

2> Connect a current shunt and a linear load to the AC source output.

3> First , the load is 1.25 ± 0.05A for 6404
2.50 ± 0.10A for 6408

adjust VR5 of B-Board until AC source display

I reading = I shunt ± 0.00A

Second , adjust load to 2.50 ± 0.10A for 6404
5.00 ± 0.20A for 6408

adjust VR4 of B-Board until I reading = I shunt ± 0.00A

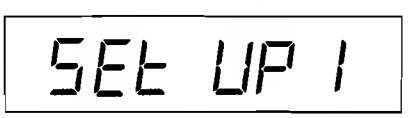
then the current measurement accuracy is completed through above procedures.

4.4.3. System Test

After finishing the recalibration of the measurement , you can check if the output voltage is within spec to the setting value , and the frequency measurement is checked as well at this test.

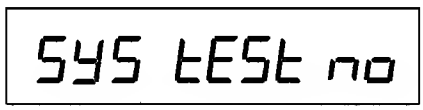
To enable the test , follow the procedures described below :

press the 〈 **SHIFT** 〉 key , the green LED turns on , then press the 〈 **0** 〉 key and hold it for 3 seconds , until the red 7-segment LEDs display the following :



Note : If the user see the red indicator LED of " LOCK " turning on before or during the 〈 **0** 〉 key , please release and press the 〈 **0** 〉 key again to switch it off. Then , press firmly the 〈 **0** 〉 key to wait for the setup screen.

1. Press 〈 **5** 〉 , and 〈 **ENTER** 〉 , then the display shows ：



2. Trun ⊙ to change the option to be " YES " and press 〈 **ENTER** 〉
   The 6408/6404 performs system test after pressing 〈 **ENTER** 〉 .
   Upon completion of test , the 6408/6404 displays test result showing " PASS " or " FAIL ". In case of failure , please refer to the trouble shooting in next chapter.

3. Press 〈 **OUT/QUIT** 〉 twice to exit from setup.

Note : Disconnect any output load when doing the system test.

Chapter5
Trouble shooting

5.1. Introduction

This section provides a technical desription of board level trouble shooting procedures for the 6408/6404 programmable AC source.

WARNING

Only personel with knowledge of electronic circuiting and an awareness with the hazards involved should test and trouble shoot the instrument.

**** CAUTION ****

To prevent static zap of ICs , always observe , antistatic technigues when assemblies are handled or serviced

5.2. Trouble shooting guide

To trouble shoot the power source , first determine what the failure is. Then refer to the information in the following paragraphs to determine the defective assembly.

For all trouble shooting procedures , the first step is to check if the power supply of $+5V_M$, $+5V_D$, $\pm 15V$ work properly. Then , start to take the corrective action according to following direction.

Failure Phenomenon	Go To	Suspect Board
1. Error Message	5.3.1.	
2. Voltage Inaccuracy	5.3.2.	
3. Fan no working	5.3.3.	P、I
4. Can not turn on	5.3.4.	I
5. OPP works abnormally		B
6. OLP works abnormally		B
7. Output waveform distorted when load applying		I、P

5.3. Trouble shooting Procedure

5.3.1. Error Message

Belows are listed all the possible error messages which may appear on the LCD display. The cause and corrective action to be taken is also shown.

Error Message	Cause	Action
RAM TEST ERR	SYSTEM memory test failure	The UX3 of 62256 of A-board might be damaged , try to replace it.
EEPROM ERR	SYSTEM EEPROM test failure	The UX7 of X24C04 of A-board might be damaged , try to replaced it.
DSP COMM ERR	CPU and DSP communication test failure	The UX1 of 64180 of A-board or the UY1 of 2105 of B-board can't communicate with each other properly , check out which one is damaged and replace it.

5.3.2. Voltage Inaccuracy

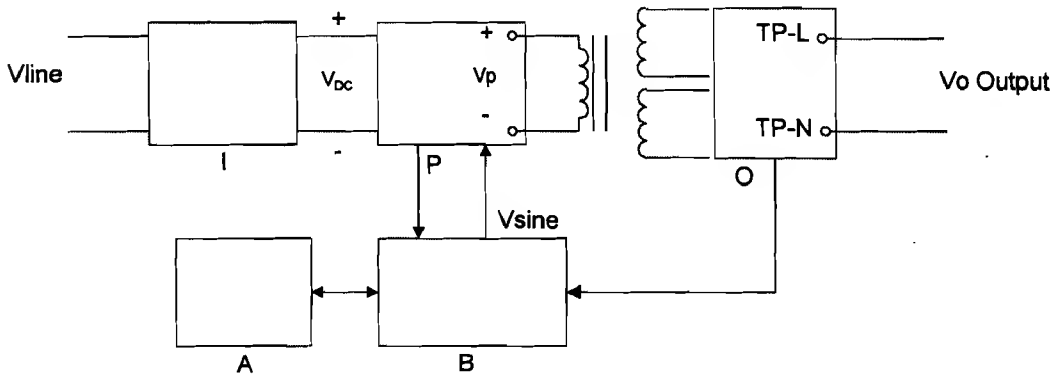
1> First , check if the sense cable is correctly connected.

2> If voltage accuracy is in the range of Vset ±3V , then take the calibration & adjustment procedure to improve the accuracy. (Refer to chapter 4)

3> If the voltage accuracy is incapable to be readjusted into the expected range , please check the following points.

If any point's voltage is out of its spec , please consult your dealer or inform Chroma directly.

4> Checking points. (150V range Vset 150V out , F = 60HZ , no load)



Test point	Range	Decription
V_{DC}	$2\sqrt{2}$ * Vline for 6404 with 110V input $\sqrt{2}$ * Vline for 6404 with 220V input 210±5 V_{DC} for 6408-1 380±10 V_{DC} for 6408-2	Test pins of " +VDC" and " PG" of P-board.
V_p	90 ± 1VAC for 6404 100 ± 1VAC for 6408-1 150 ± 1.5VAC for 6408-2	Terminals of "V_o+" and "V-" of P-board.
V_o	150 ± 3 VAC for 6404 、 6408-1 、 6408-2	Test pins of "TP-L" and "TP-N" of O-board.
Vsine	7.07 ± 0.23 VAC for all models	Test pins of "TP3" and "AG" of B-board

5.3.3. Fan No Working

1> Check the FAN connector "JFAN" on the P-board is loose or not.
If loose , reconnect it firmly.

2> Check the voltage between the test pins "+15V" and "AG" on the B-board , is it about
15±1V , if not , try to replace the I-board.

3> Check the voltage between the test pins "V-FAN" and "CG" in the P-board ; is it abou
7±1V , if not , try to replace the P-board.

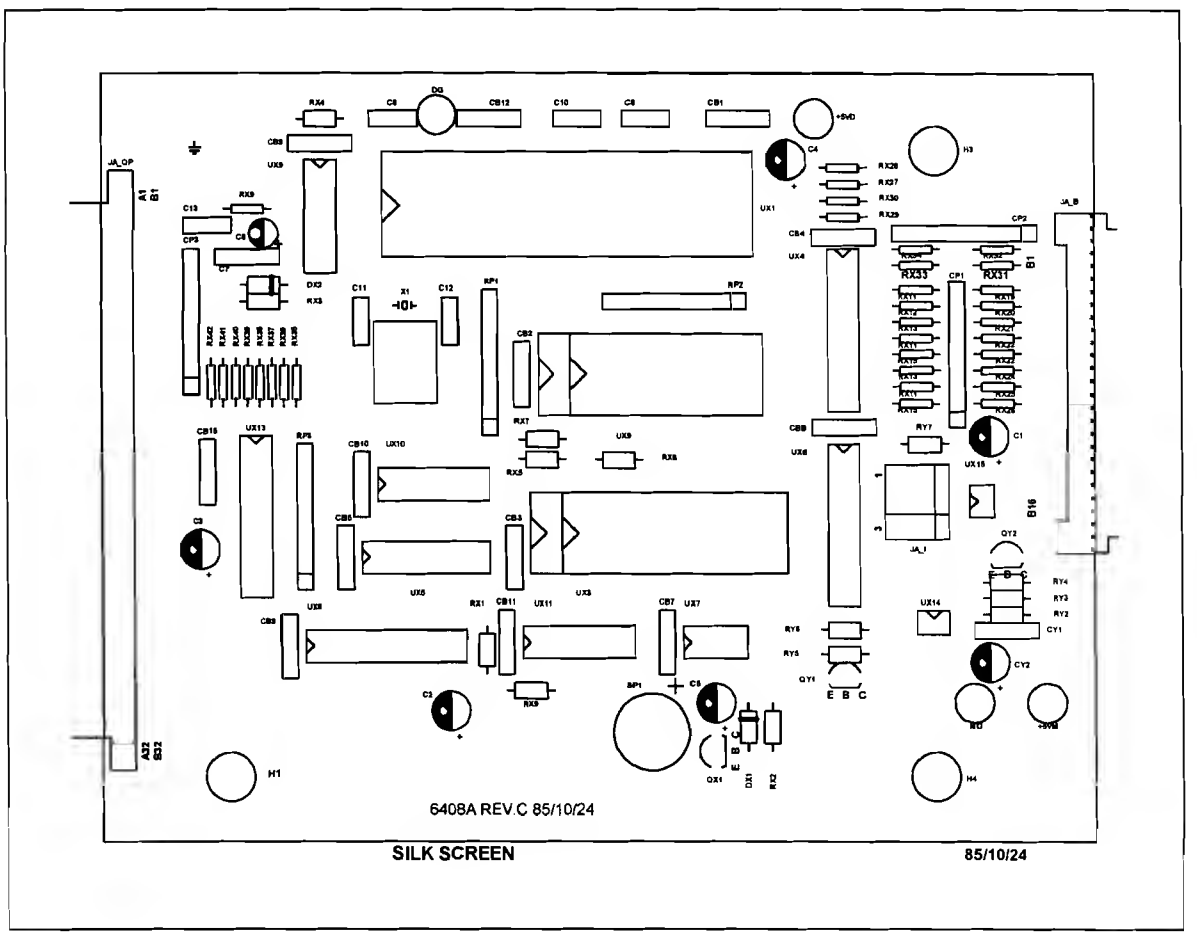
5.3.4. Can Not Turn On

1> First , check if the input voltage is correct ?

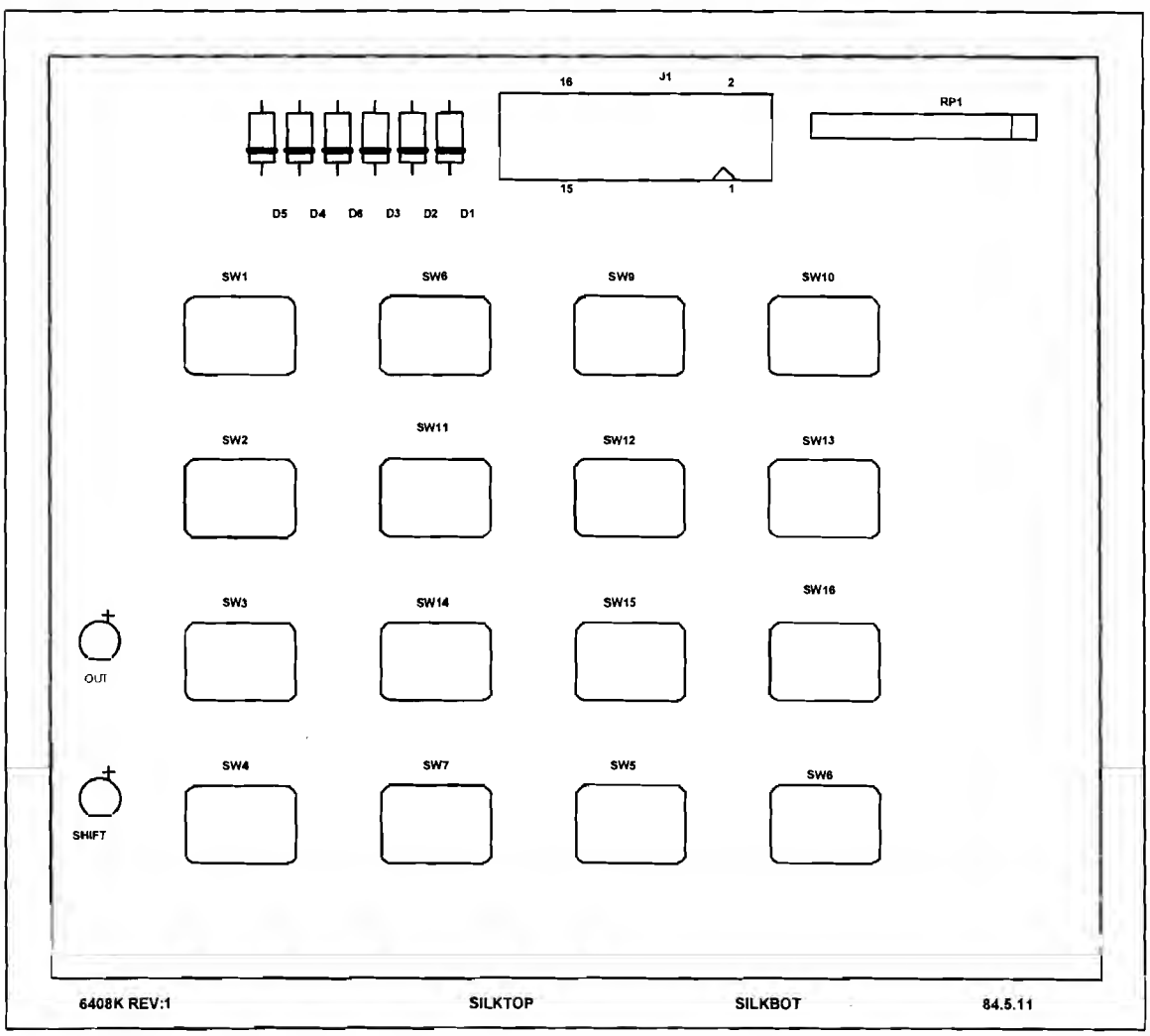
2> Check the din connectors between I 、 P 、 O 、 A and B boards are loose , reconnec
them firmly if loose.

3> Check if the FAN is working , if not , try to replace the I-board.

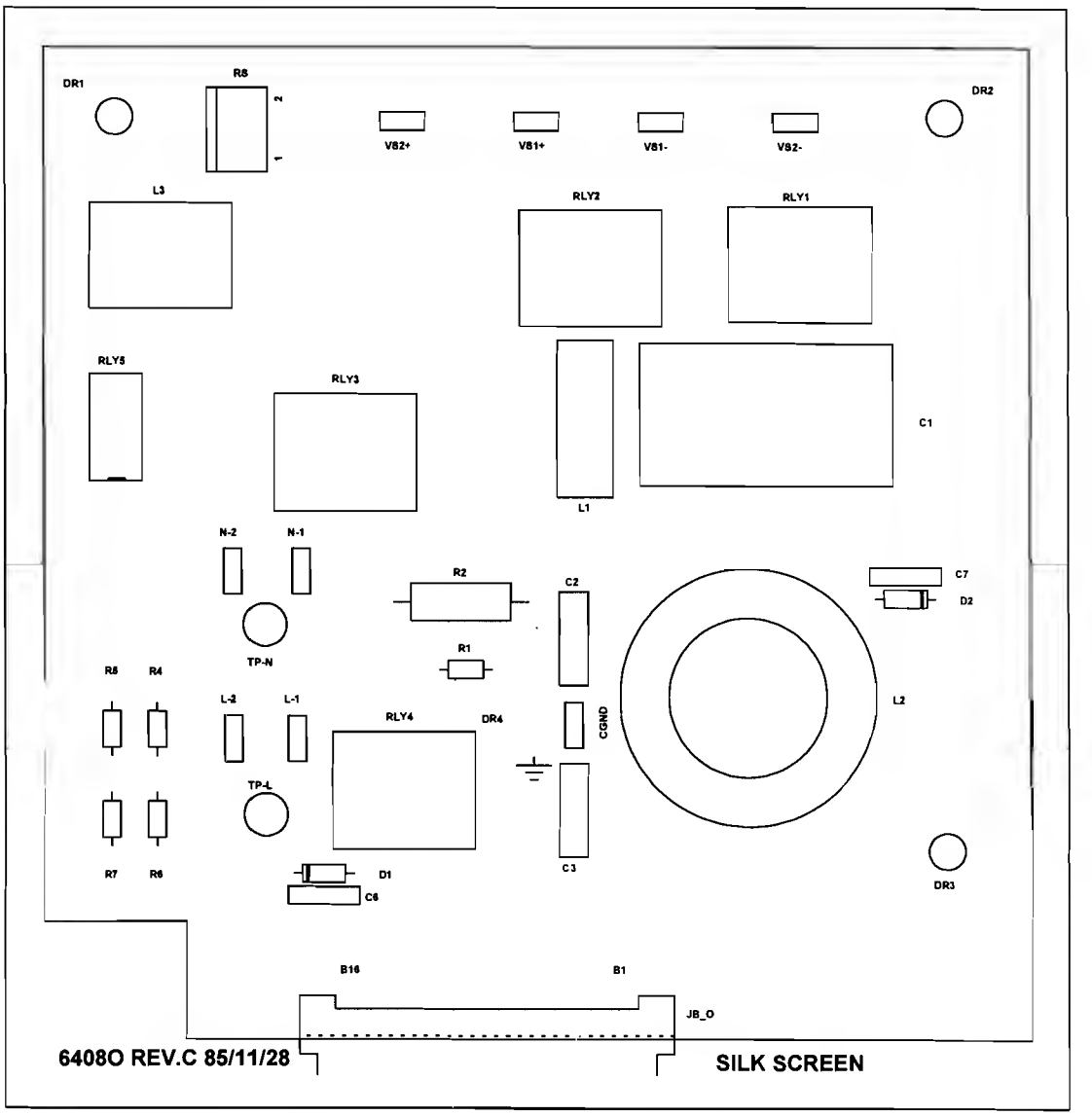
Component Location



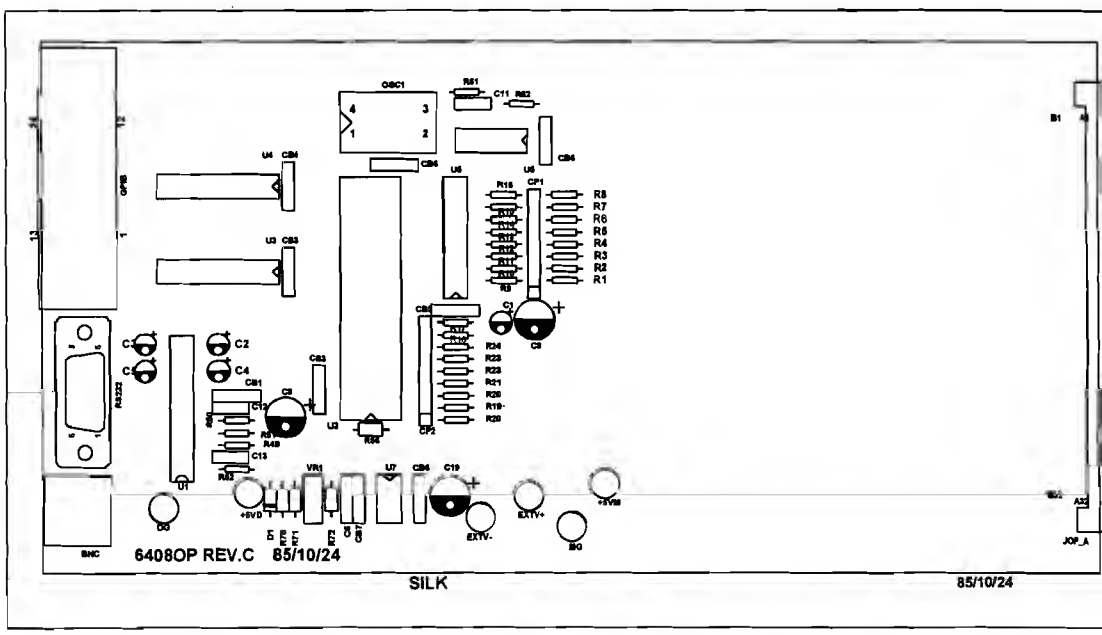
CPU Board


16
J1
2
RP1
15
1
D5 D4 D6 D3 D2 D1
SW1
SW6
SW9
SW10
SW2
SW11
SW12
SW13
SW3
SW14
SW15
SW16
OUT
SW4
SW7
SW5
SW8
SHIFT
6408K REV:1
SILKTOP
SILKBOT
84.5.11

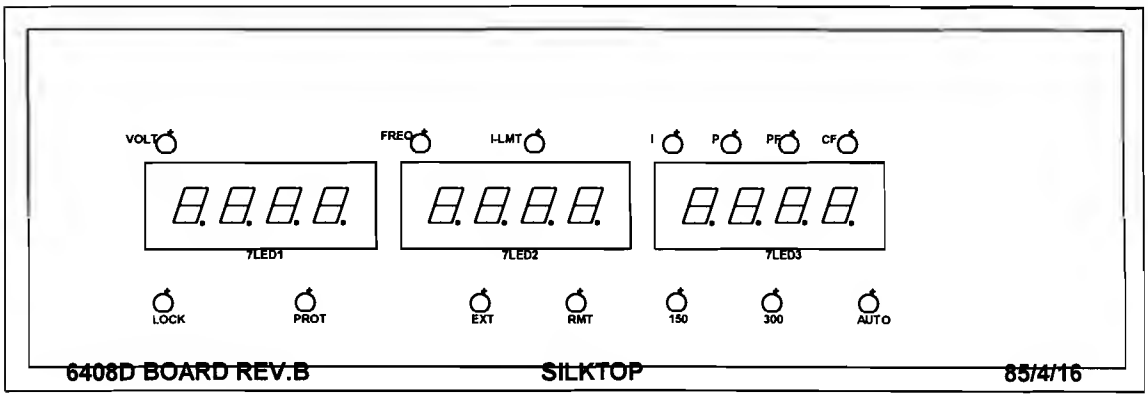
Key Board



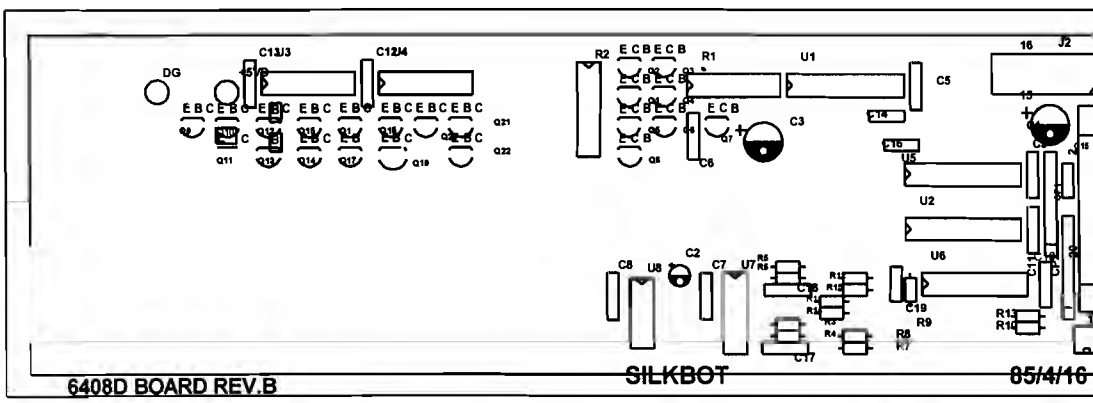
Output Board



GPIB Board



Display Board



Display Board

Measurement and Control Board

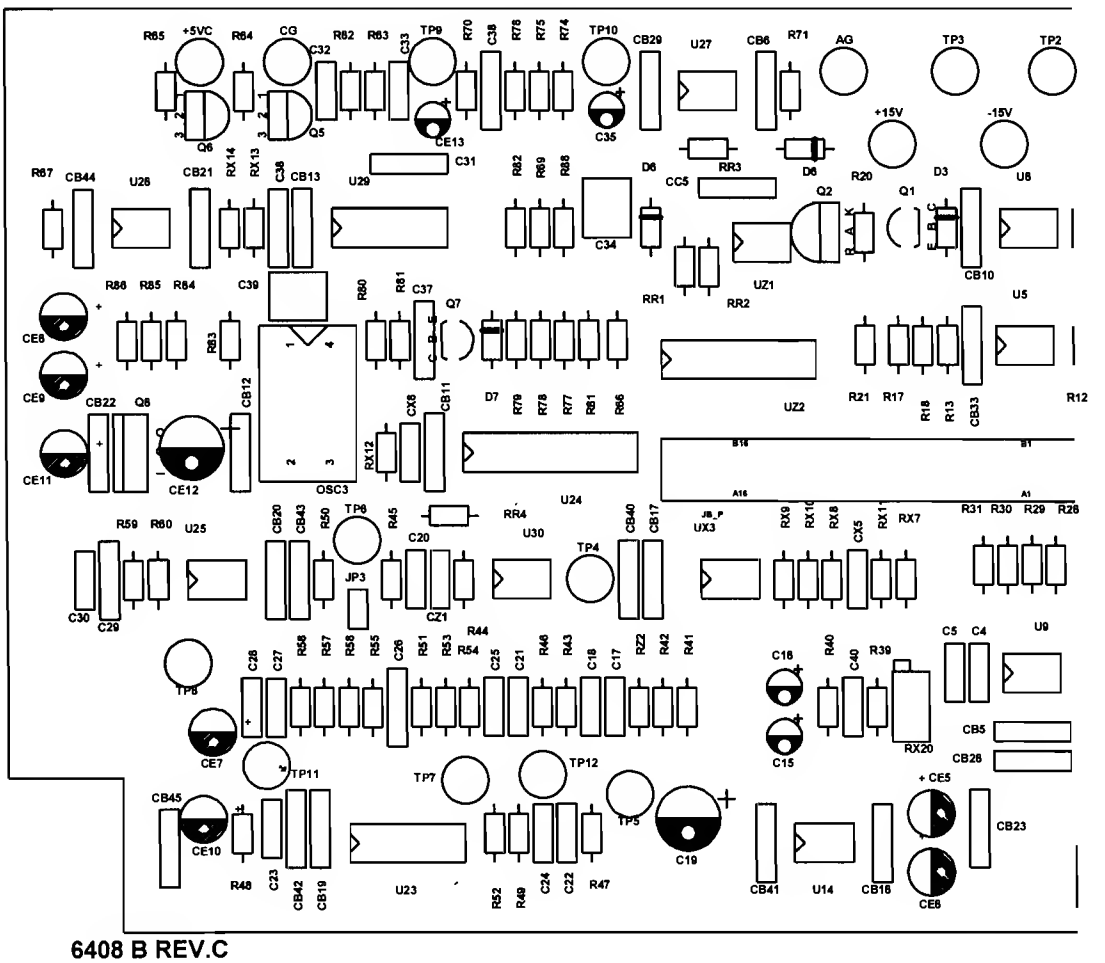


Fig-1

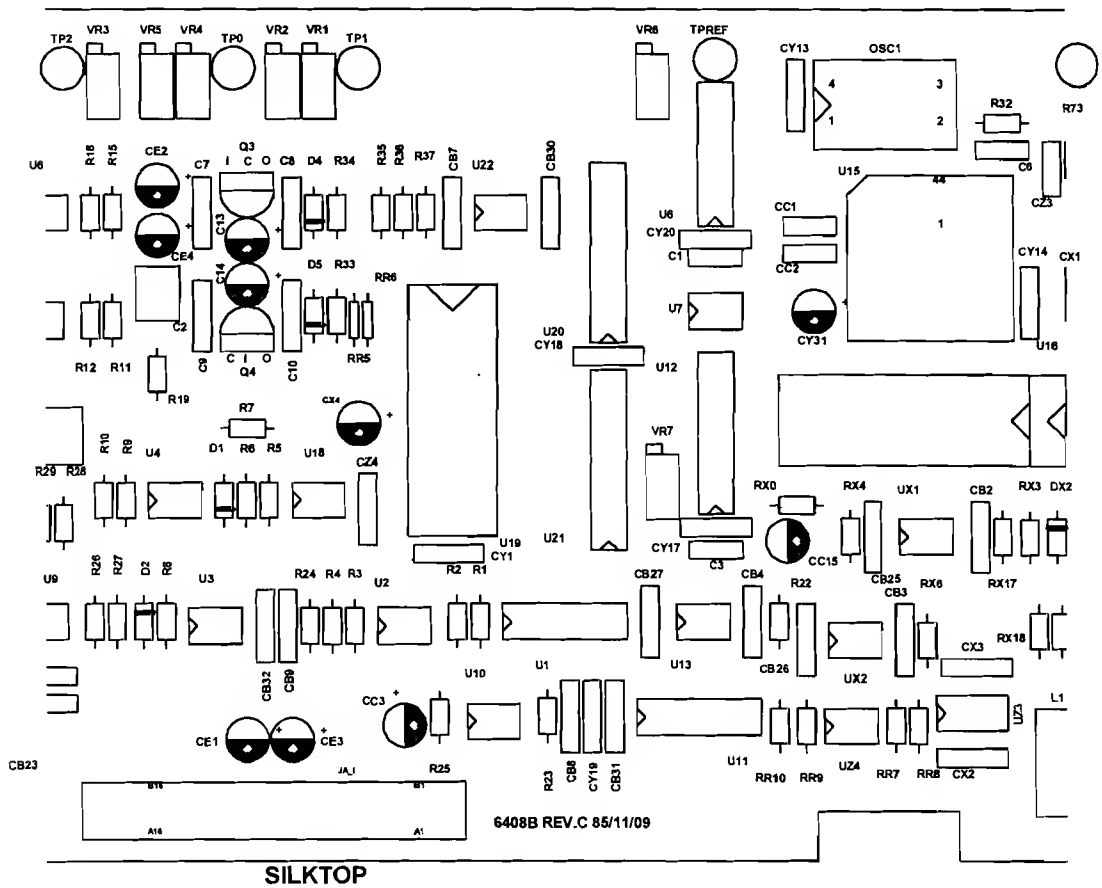

TP2
VR3
VR5
VR4
TP0
VR2
VR1
TP1
VR6
TPREF
CY13
OSC1
R32
R73
U6
R18
R15
CE2
C7
Q3
C8
D4
R34
R35
R36
R37
CB7
U22
CB30
U15
C6
CZ3
CC1
CC2
CY14
CX1
U16
CY31
U7
U20
CY18
U12
C13
CE4
C14
D5
R33
RR6
C2
R12
R11
C9
Q4
C10
RR5
R19
R7
CX4
R10
R9
U4
D1
R6
R5
U18
CZ4
VR7
R29
R28
RX0
RX4
UX1
CB2
RX3
DX2
CC15
R22
CB25
CB3
RX6
RX17
U9
R26
R27
D2
R8
U3
R24
R4
R3
U2
R2
R1
U19
CY1
U21
CY17
C3
CBZ7
CB4
U13
CB26
UX2
CX3
RX18
U10
U1
CB32
CB9
CC3
CE1
CE3
CB23
R25
R23
CB8
CY19
CB31
U11
RR10
RR9
UZ4
RR7
RR8
CX2
UZ3
L1
6408B REV.C 85/11/09
SILKTOP

Fig-2

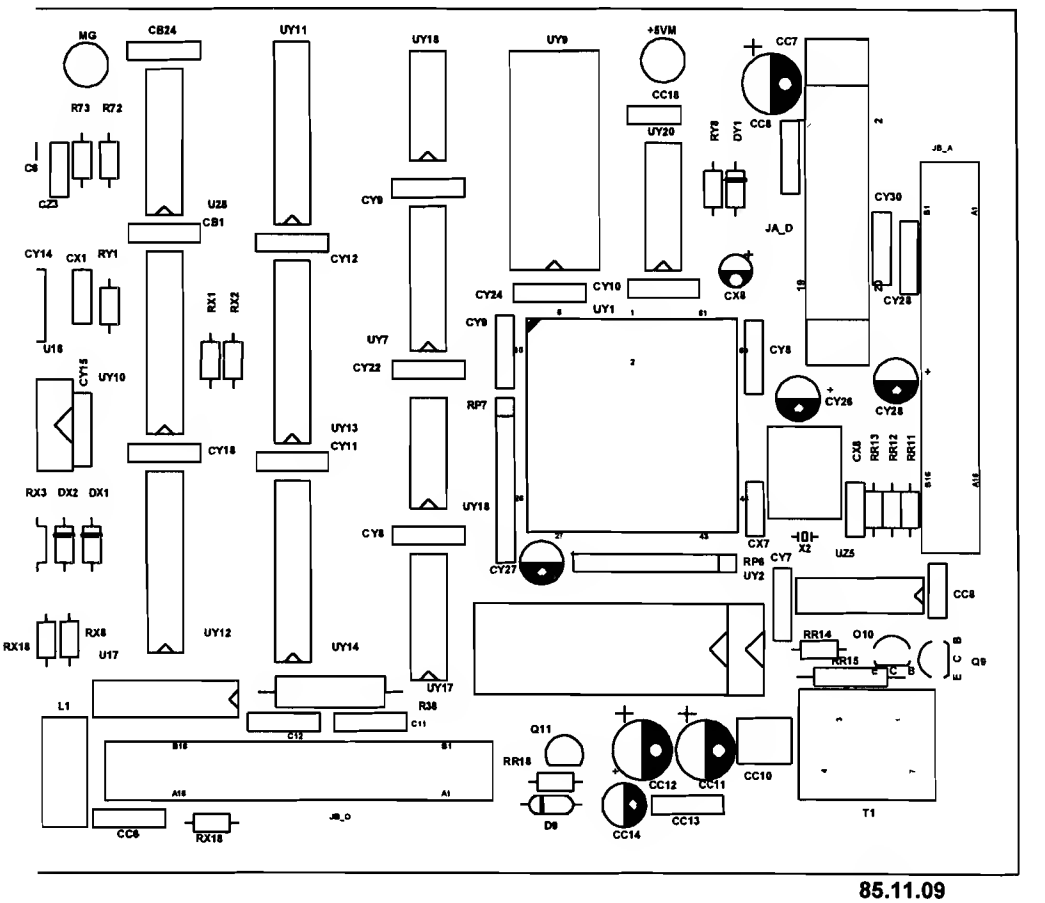

MG
CB24
UY11
UY18
UY9
+5VM
CC7
CC18
UY20
CC8
R73 R72
C8
C23
U28
CB1
CY12
CY9
CY14 CX1 RY1
U16
RX1 RX2
UY7
CY22
CY24
CY10
UY1
CX8
CY30
CY29
JA_D
CY8
CY26
CY28
CY15
UY10
RP7
UY13
CY11
CY18
RX3 DX2 DX1
UY18
CY6
CX7
X2
UZ5
RR13 RR12 RR11
CY27
RP6
UY2
CY7
CC9
RX18
RX8
U17
UY12
UY14
UY17
RR14
Q10
RR15
Q9
L1
R38
C12
C11
Q11
RR16
CC12
CC11
CC10
T1
D9
CC14
CC13
CC6
RX19
85.11.09

Fig-3

Inverter Board

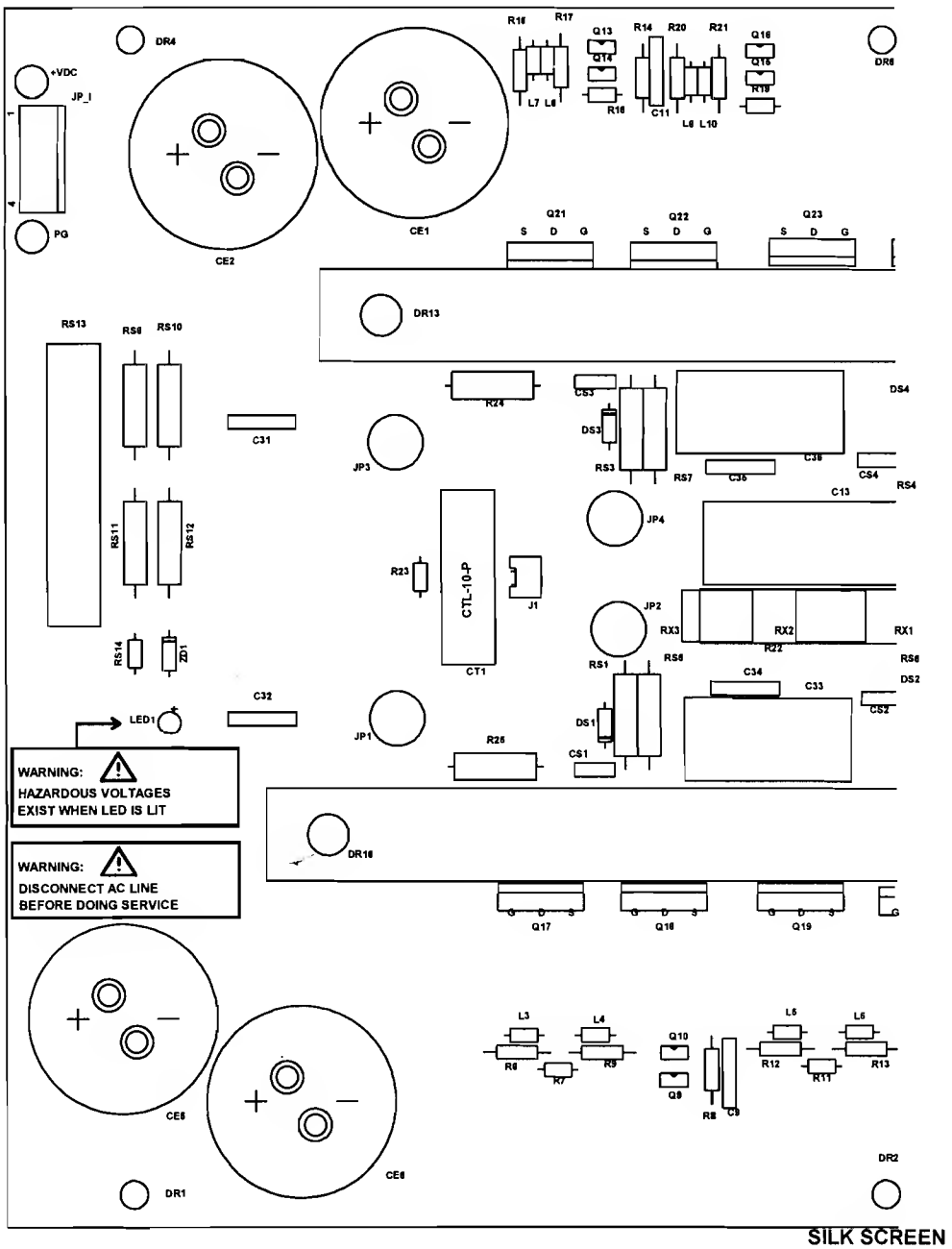


Fig-1

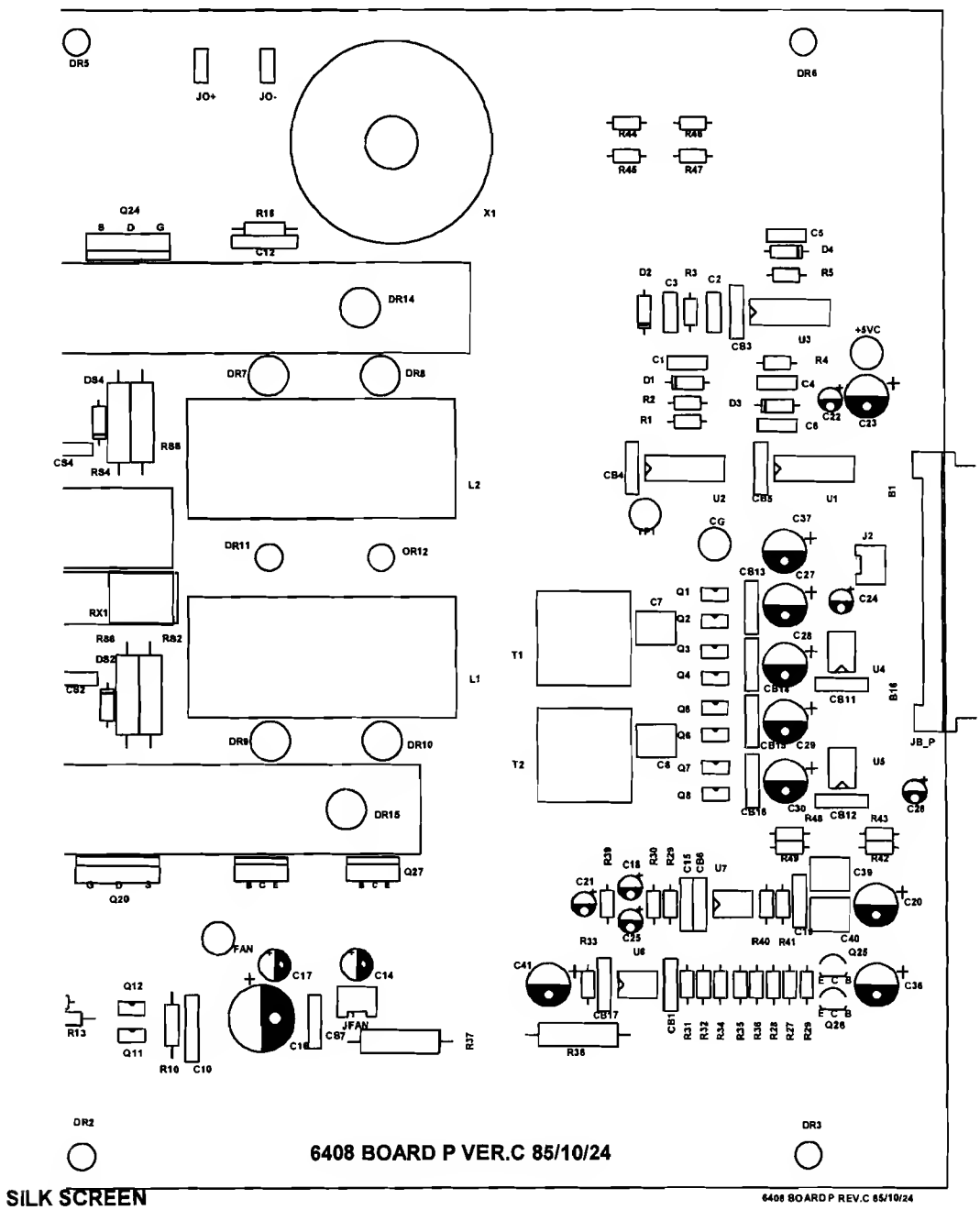

DR5
DR6
JO+
JO-
X1
R44
R46
R45
R47
Q24
S D G
R16
C12
DR14
C5
D4
R5
D2
R3
C3
C2
CB3
U3
+5VC
C1
R4
D1
C4
R2
D3
R1
C6
C22
C23
DR7
DR8
DS4
CS4
RS4
R88
L2
CB4
U2
CB5
U1
B1
FP1
CG
C37
J2
DR11
OR12
CB13
C27
C7
Q1
Q2
Q3
Q4
C24
RX1
R86
R82
DS2
CS2
C28
T1
U4
CB11
L1
Q5
Q6
CB14
C29
JB_P
DR9
DR10
T2
C8
Q7
Q8
U5
CB16
C30
C26
DR15
R48
CB12
R43
R49
R42
Q27
Q20
C39
C18
R39
R30
R29
C15
CB6
U7
C21
C20
R33
C25
R40
R41
C19
C40
U6
Q25
C41
C36
CB17
CB1
R31
R32
R34
R35
R36
R28
R27
R29
Q26
R38
FAN
C17
C14
Q12
R13
Q11
JFAN
C16
CB7
R37
R10
C10
DR2
DR3
6408 BOARD P VER.C 85/10/24
SILK SCREEN
6408 BOARD P REV.C 85/10/24

Fig-2

6404 A/D Board

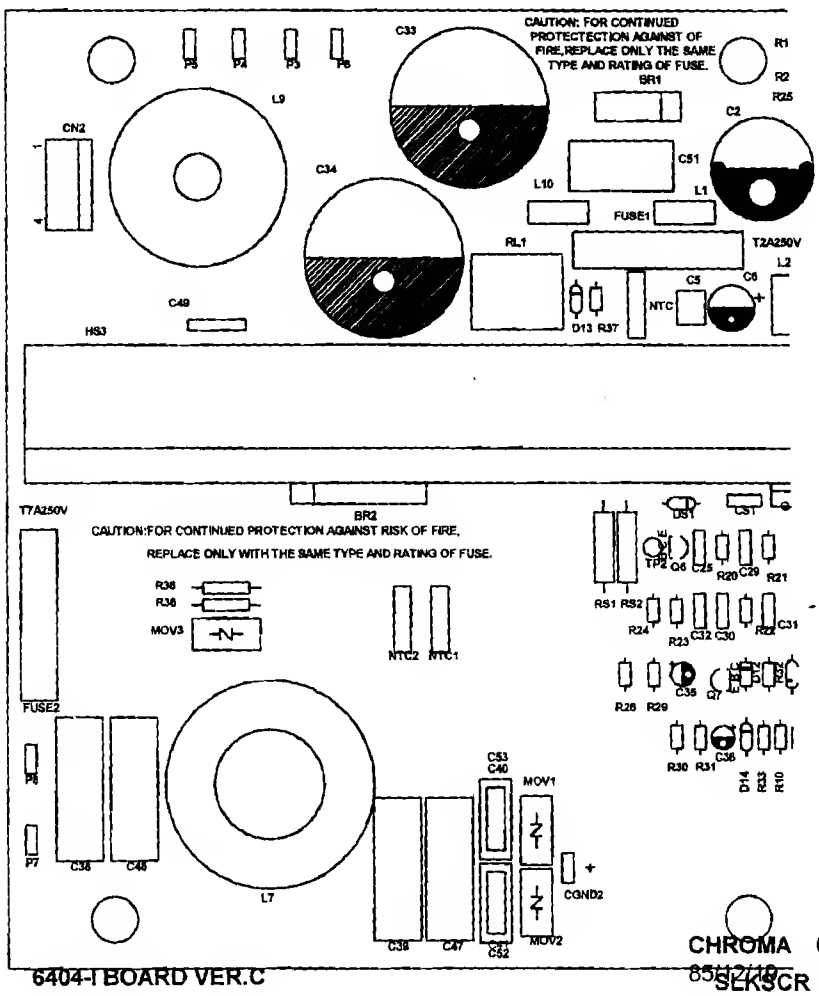


Fig-1

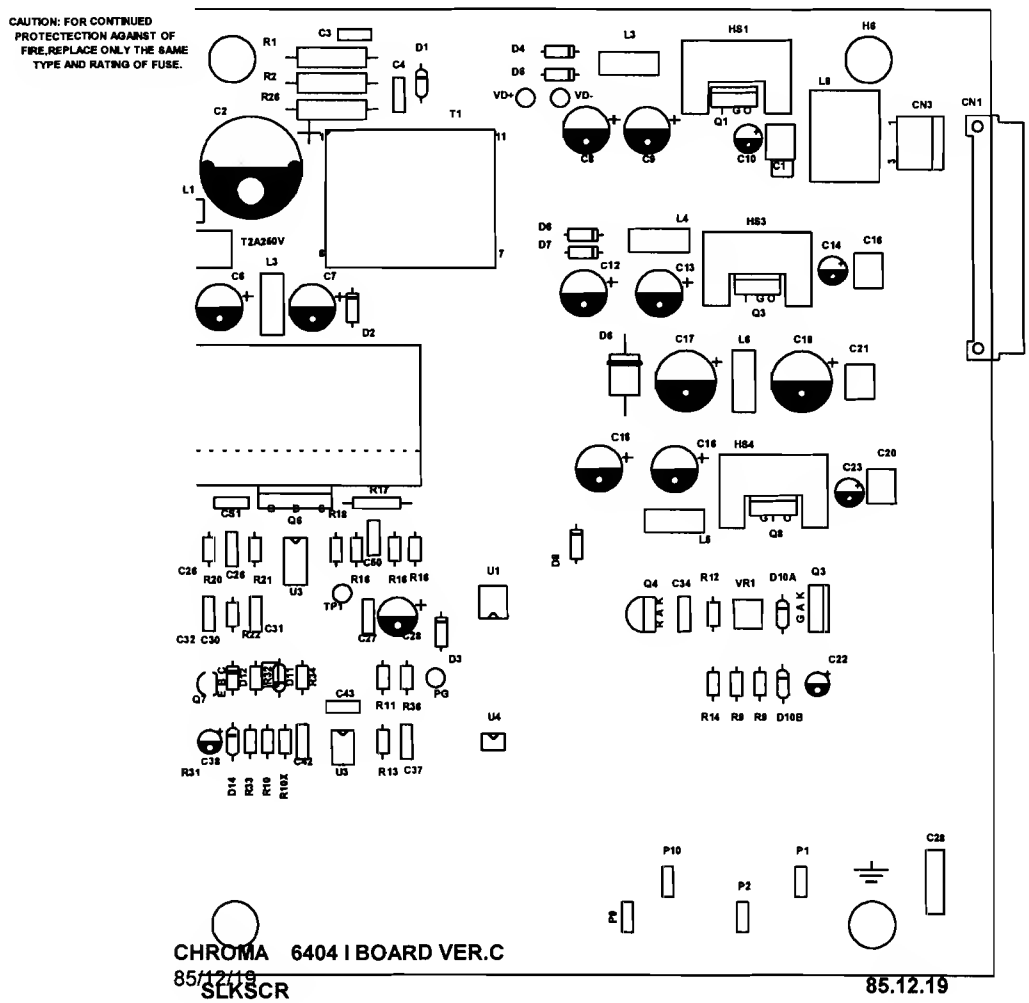

CAUTION: FOR CONTINUED PROTECTECTION AGAINST OF FIRE,REPLACE ONLY THE SAME TYPE AND RATING OF FUSE.
CHROMA 6404 I BOARD VER.C
85/12/19
SLKSCR
85.12.19

Fig-2

6408 A/D Board

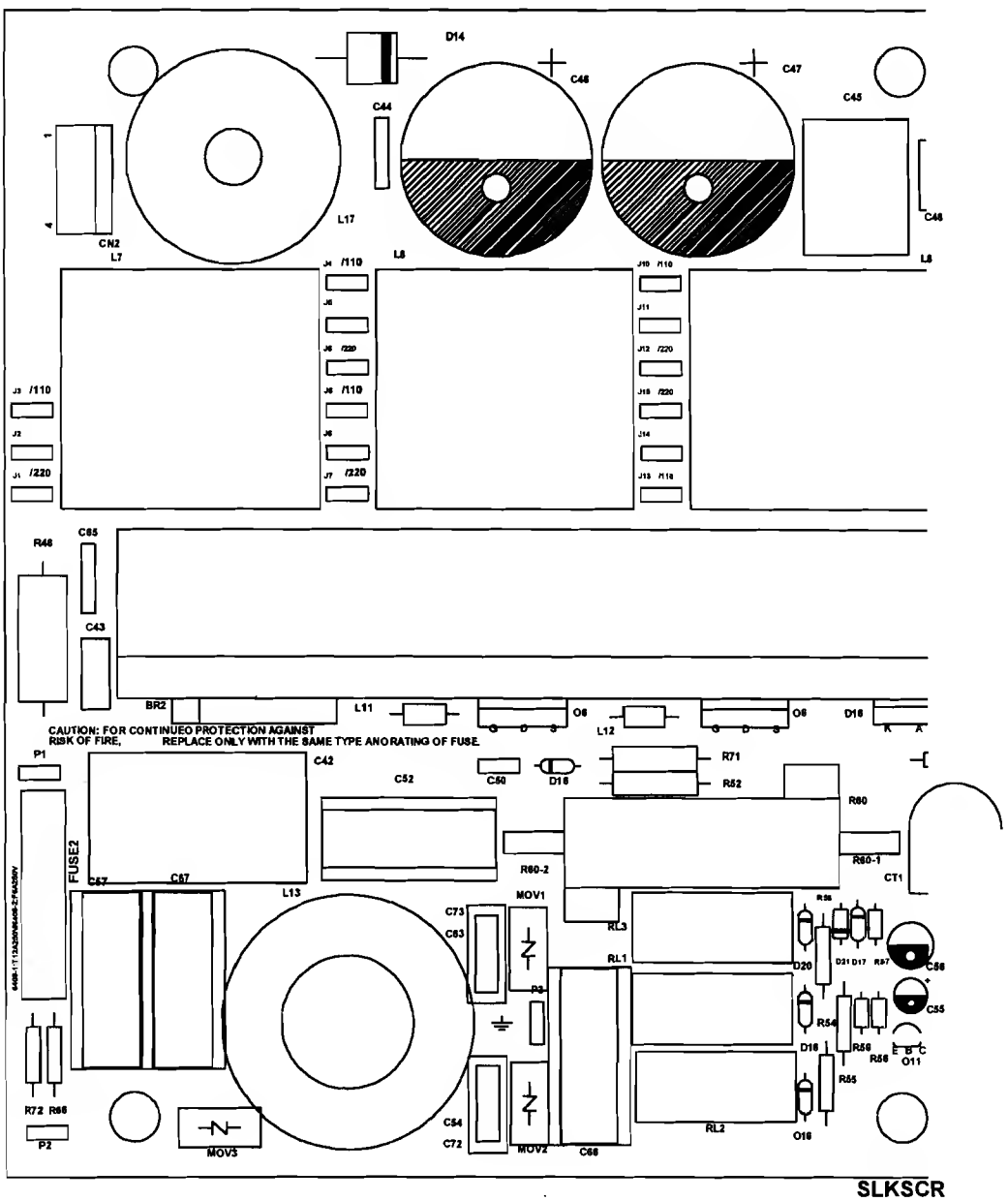


Fig-1

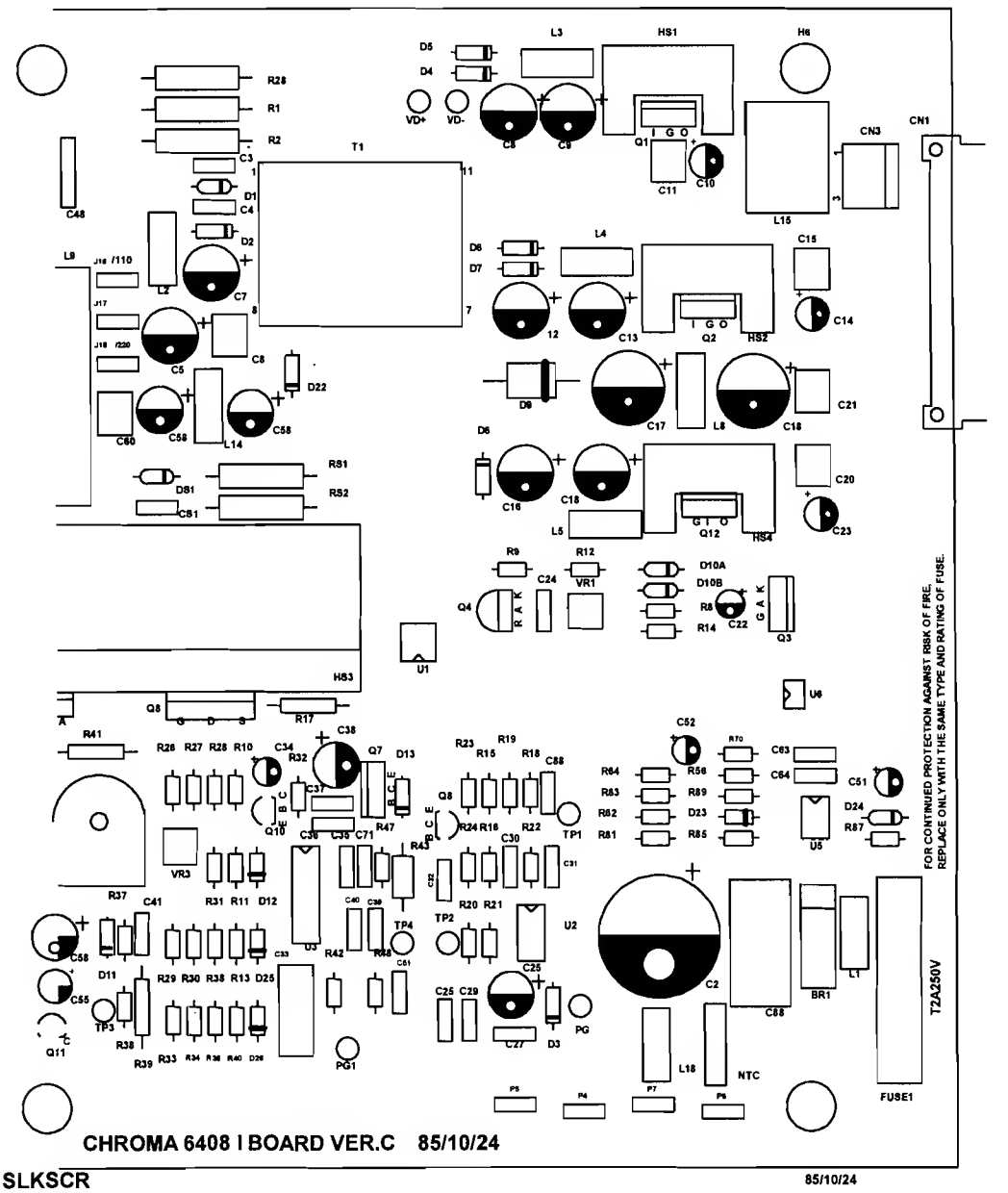

CHROMA 6408 I BOARD VER.C 85/10/24
SLKSCR
85/10/24
FOR CONTINUED PROTECTION AGAINST RISK OF FIRE,
REPLACE ONLY WITH THE SAME TYPE AND RATING OF FUSE.
T2A250V

Fig-2

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